PHEV Conversion Kit Users Manual

for 1997-2003 Prius

Warning:

- You are strongly recommended to have this kit professionally installed!
- High Voltage (HV), Direct Current (DC) Warning: Traction battery Packs, motors, chargers, and other HV sources could cause serious injury or death if proper precautions are not taken while working on or around such high voltage direct current sources.
- Please note that anyone attempting to install this conversion kit and modify their vehicle is doing so at their own discretion and risk.
- Warranty: In performing some of these modifications it is possible, though unlikely, to void your warranty with the vehicle's manufacturer. Please check with your original vehicle manufacturer / dealer for confirmation.
- This is a patent pending technology.

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Attention

1. Please read instructions before installation.
2. Never connect wires improperly.
3. New batteries should be re-charged to full and balanced before use.
4. Please check the batteries' voltage and balance regularly for the first few times you drive the vehicle.
5. To extend battery life, equipment must be recharged, using the 110VAC household powered charger provided, to full each time and the cells need to be fully balanced after charging.
6. The circuit breaker in the enclosure box is set to be switched off automatically if the current exceeds a pre-set limit (100A). In the event this breaker switches off you will then need to manually switch it back on before use.
7. Please switch the equipment off immediately if a defect is found while driving.
8. Please do not disassemble the components if the equipment is working normally.

Product Overview

The Plug-in Hybrid Electric Vehicle Conversion Kit (PHEV) is a rechargeable battery set that supplements a hybrid vehicle battery. It supplies electricity stored in the supplementary battery, which is charged from an AC wall socket, which provides for 20 to 40 mile of electrically assisted driving per charge, sufficient for most normal daily commutes. It is safe, reliable, saves money, and is user and environmentally friendly.

What is Included in this Product

- 16 / 32 cells for 2KWH / 4KWH, Lithium-Ion batteries
- Battery balancers—one for every 8 cells, monitoring and balancing battery voltages to avoid over or under charges to individual cells. This can extend battery life by a factor of 3.
- 48V / 15A high power charger
- 3000W DC / DC Converter and Controller
- Fire extinguisher for protecting when the temperature is over 105 (Please open the cover and take out the blue insulative inserter to allow it to work.)
- Automatic DC circuit breaker—to disconnect high voltage equipment operation in the event of a high current fault.
- Easily installed enclosure, simple to use system.

How the System Works

110VAC household electricity → Enginer PHEV conversion kit → Hybrid vehicle OEM Stock battery → Hybrid electric motor

System Specifications

Batteries	Type	Capacity	Average Fuel Economy	EV/Mixed Range	Charge Time
16 Cells	Lithium-Ion	40 Ah	85 mpg	10 (20)	3 hours
32 Cells		80 Ah	85 mpg	20 (40)	5 hours

- Use 110V AC source only.

Warranty

Two-year limited parts warranty applies. If equipment defect occurs in normal use conditions, Enginer shall repair the equipment or change defective components in this conversion kit only.

Use this information at your own risk: Other than as specified above there is no additional warranty expressed nor implied and Enginer shall not be liable for any of your past, present, nor future actions. Even if you perform these modifications to the letter you could still damage any number of components in your vehicle causing it to no longer function. Even if it appears to function properly your actions may cause it to self destruct with collateral damage to surrounding properties other than your vehicle. By utilizing these ideas and instructions in an attempting to enhance national security, reduce gas consumption, vehicle "emissions", your carbon footprint, or smog, you do so at your own risk & peril.

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Preparing and Assembling the PHEV Conversion Kit

Please carefully read and understand these instructions before opening the product box.

1. Prepare at least a 7x7 feet flat area on the ground near the end of your hybrid vehicle, and cover the floor with 5x5 feet soft and flat cloth or cardboard.
2. The equipment is heavy and should be removed and handled by two adults.
3. Knock open the wooden box, if there is one, and then open the cardboard box inside.
4. Take out accessory bags and check against the following list to count whether components are complete.
    - One 48cm lid supporting pole
    - One plastic holding bracket.
    - Six red and black jumper wires with ring terminal.
    - Two long wires for connecting the batteries in parallel
    - ECU signal wires (green, brown and white)
    - One switch panel with on/off switch, red and green LED lights
    - 2 sets of equipment mounting brackets and screws
    - Four screws for mounting the box cover
    - One double-sized spanner
    - A set of two fire extinguisher holders and mounting screws.
    - One thread for converter and charger.
    - One 0.2m corrugated pipe.
    - 1:1drawing for making mounting holes on car.
5. Place the above accessories in a place not impeding your later installation. Take out the foam plastic cover from the cardboard box and pull out the stainless steel box, this requires two people with both hands, carefully and steadily move out the entire stainless steel box and place it gently on the floor. Do not tilt or turn over the equipment.
6. The equipment weights about 65 lbs without batteries or 115 lbs (2KWH) to 165 lbs (4KWH) with batteries. **Enginer** strongly suggests you use professional lifting equipment, or operators that are strong enough to lift this much weight. Slowly handle the equipment to avoid physical injury or equipment damage.
7. Take the supporting pole from accessories and hold it with your right hand. Open the enclosure box cover and stick the pole in the hole at right hand side close to your body and prop up the cover on the other end. Take out a small white plastic bracket holder from accessories and push it hard into a small hole on the right side of the steel box to rest the pole after use.
8. After popping up the cover firmly and checking that it is safe with no risk of dropping down, take out all insulating foam gently and check inside component against the following list:
    - Stainless steel box and cover (833 x 505.5 x 157 mm)
    - Batteries: 4 sets of 4 cells (2KWH), or 8 sets of 4 cells (4KWH) depending on what you ordered. Please make sure batteries match your order.
    - Two battery mounting frames to fix the two rows of batteries.
    - Balancers fixed on the rear (the side close to your body) battery frame: two balancers for 2KWH kit or 4 for 4KWH kit, black, each linking 8 cells with wires.
    - One converter mounted back left, connecting batteries with one red and one black power inlet wires with a pair of Anderson plug. It also contains one red and one black power outlet, and a 6 pin cable.
    - One charger mounted on right back connecting black power inlet cable, with left hand side one red and one black cable with an Anderson plug (shared with converter).
    - One ventilation fan on left lower corner.
    - One circuit breaker mounted on top of charger.

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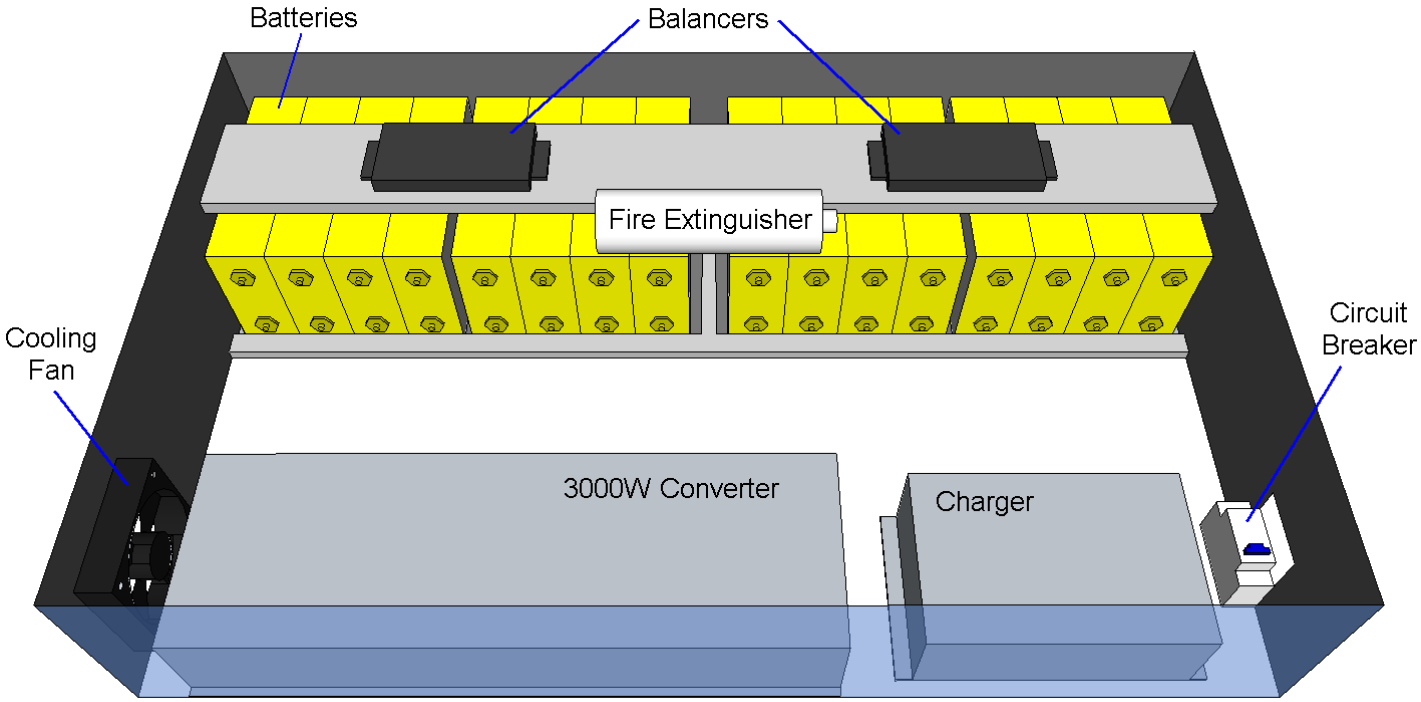


9. Wiring Check:
    - Make sure circuit breaker is in the OFF position, Anderson plug from charger / converter is disconnected, balancers' interfaces are pulled off; \
    - Charger and converter connections are connected firmly;
    - Connection between black wires from converter and circuit breaker is connected firmly;
    - Connection between circuit breaker and another black wire is connected firmly.
    - Positive and negative of each group of batteries are connected firmly (16 cells in series, two 16 cell packs in parallel shown in FIG1), terminal plastic covers are in position.

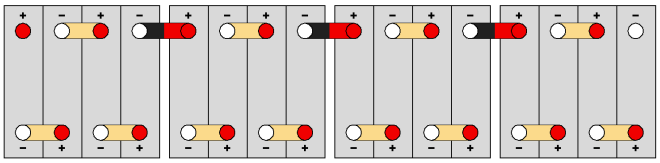
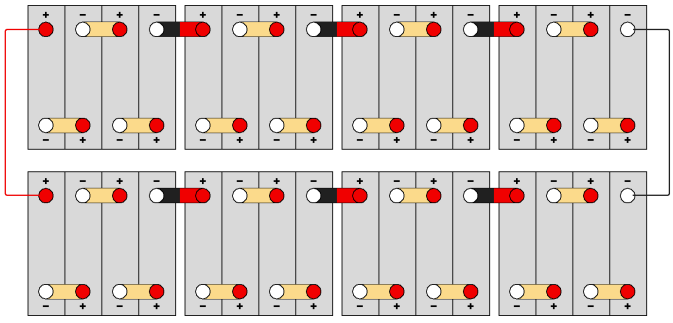


Figure 2: Connection of one row batteries (2KWH)



Connection of two rows of batteries (4KWH)

- Connection between balancers and batteries are normal and firm:

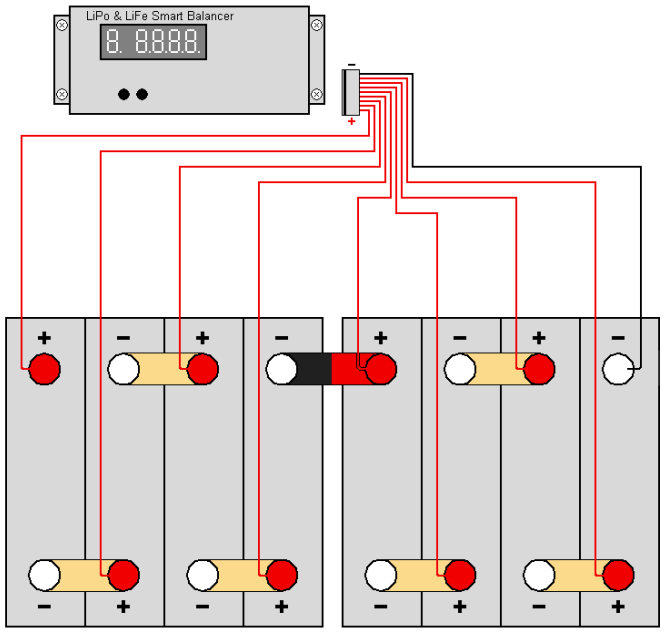
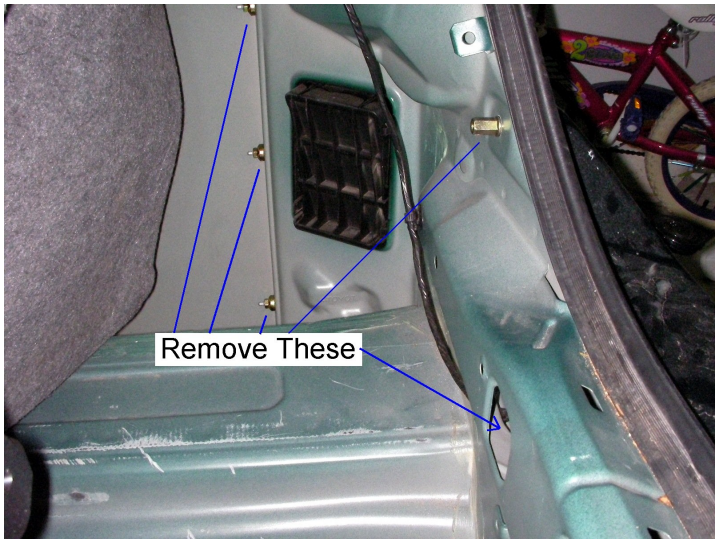


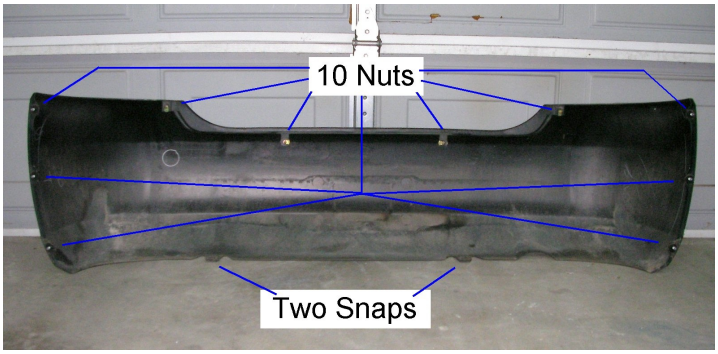
Figure 3: Balancer Connection

10. Wiring:
    - Pull off the protection cap of the battery terminals (positive and negative) between two battery packs, use red / black short jumper cable to put them in series as shown in Figure 2. If it is a 4KWH model, connect two strings of the 2KWH battery packs in parallel (positive to positive, negative to negative terminals);
    - Connect the DC/DC converter (11) to the end terminals of the battery pack, red to positive and black for negative.
    - Connect the white connectors to the balancers.
    - Connect the gray Anderson connector to the charger.
11. Remove the lid supporting bar, close the cover and tighten two screws on both side of the cover.
12. The conversion kit assemble is completed and ready to be installed into the vehicle.

Installing Bumper Plug

With your kit you should have a plug that looks like the picture on the left. You will need to remove the bumper in order to install this. The bumper is easy to remove as long as you know how. You will need to remove the carpet inside the trunk, by pulling out the 'christmas tree fasteners' holding it in place. There is also a plastic piece directly in the center that comes off. Then you will need to remove the 12V battery on the left and a piece of foam on the right. This will reveal all 10 nuts which are holding the bumper on. You can see in the picture to the right where 5 of them are located on the right side of the trunk. There are also two plastic snaps on the bottom of the car that will need to be removed.





The next picture shows the inside of the bumper so you can see exactly where all of the bolts and snaps are. Also shown is the circle drawn for the hole to be cut for the plug. An easy trick for determining the size of the hole to be cut is by using the metal ring nut as a template. Use the inside of the nut and draw a circle on the bumper.

Placement of the hole is important because it cannot interfere with the metal structure of the bumper behind the plastic. Also you want to choose an area on the bumper that is as flat as possible. Make certain that the plug will have room on the inside when the bumper is re-attached before drilling the hole. It is best to use a 1¾" hole-saw for the cut, then file it slightly larger until the plug fits snugly. If you drill the hole too large,

there will be no way to fix it.

You will need to drill a hole in the sheet metal inside the trunk to allow the charging wire to extend from the plug on the bumper to the inside of the trunk. You will need to drill the hole large enough to accommodate the cable and the plastic grommet.

Balancers

The battery balancers are designed to keep the individual cells in your battery pack at approximately the same voltage. If one cell becomes charged more than the other cells, then it could become damaged by overcharging while the charger attempts to bring the other cells in the pack up to the correct state of charge. Conversely, if one cell is charged less, than it could be damaged during discharging by being dicharged too low.

- Each balancer controls 8 cells.
- After setup, press "Start / Stop" to start balancing process.
- The balancer screen will show the following data in order: Total voltage of the 8 cells, Voltages of each individual cell, and standard deviation of voltage.
- A red dot flashes during balancing and disappears when voltage difference is less than 0.01V.
- The balancer will alert if any cell voltage drops below 2.8V or is charged above 3.75V.

Initial Charging Instructions

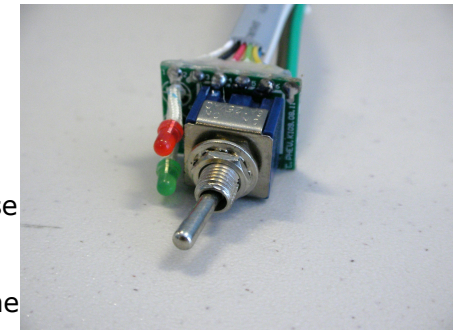
When charging the batteries for the first time, it is important to monitor them closely. It is recommended to turn off the charger when hearing the balancer alert, or turn off the charger when highest cell voltage reaches 3.5V (it is about 90% charged) in the first two weeks of usage in order to prevent overcharge. The charger is designed to shut off when the pack is full, however if the cells are unbalanced or not yet broken-in, then it is still possible to overcharge and damage a cell. After the initial break-in period, it should be possible to allow the batteries to charge unsupervised.

Installing Dashboard Panel

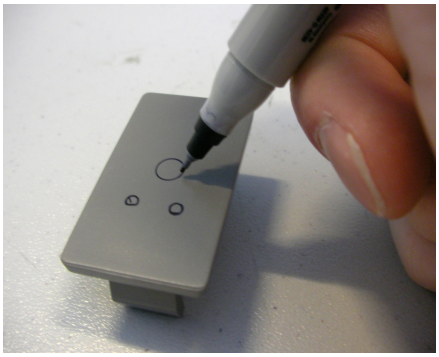
You will need to partially remove the plastic piece below the steering wheel. There are only 2 bolts holding it in, both are located at the bottom (on the left and right) and the top is only held in place by snaps. Once it is partially removed, you will easily be able to remove an extra knock-out plate. Most 2001-2003 Prius will have 3 blanks to choose from.

You will need to modify one of the knock-out plates to accommodate the new switch and LEDs. You will need to drill 3 holes, the switch is 6mm diameter and the LEDs are 3mm each. If you received a pre-drilled plate for a different model vehicle, you can turn that plate upside-down and use it as a template to draw the holes on the new plate.

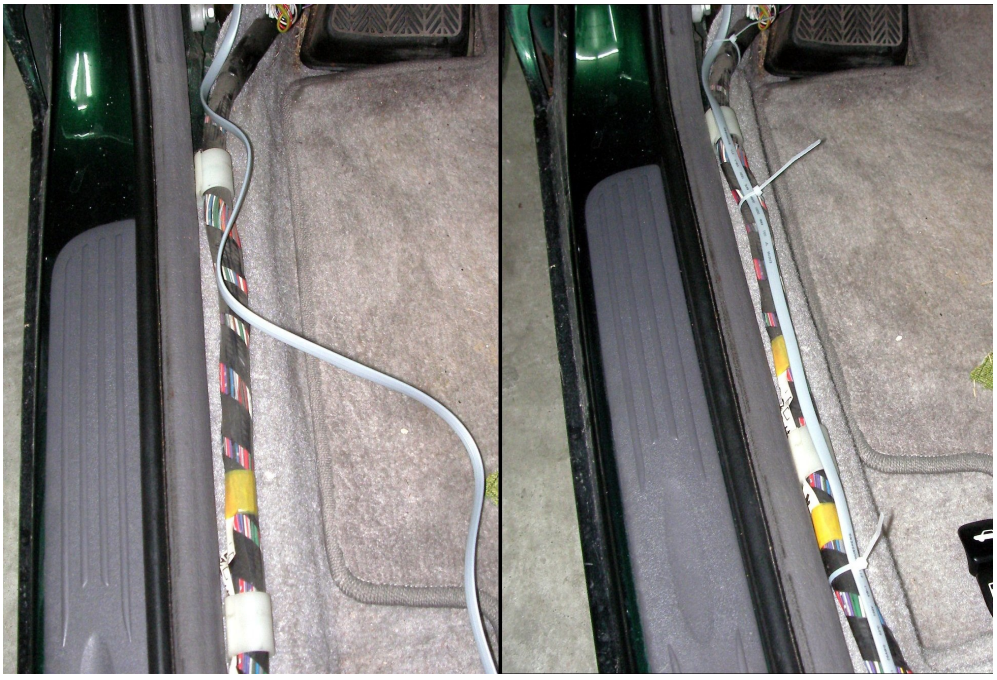
There is a long ECU signal wire included in the kit, which resembles a telephone wire. This will connect to the 3000W DC-DC converter in the rear of the car, and will connect to the switch panel on the dash of the car. You will need to remove the kick panels, scuff plates, and various plastic pieces along the edge of the carpet along side the doors in order to properly install this cable and keep it out of sight. When you remove the panels, you will see a factory wire-harness already exists along this path. Use some nylon zip-ties and fasten the new cable to the existing cable harness as shown in the pictures below.



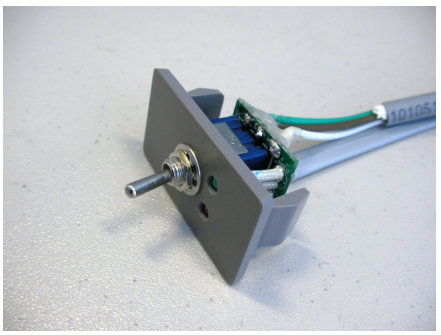
Bare Panel Switch



Preparing Holes to Drill



Under Scuff-Plate / with Zip Ties



Finished Plate

Plate Installed

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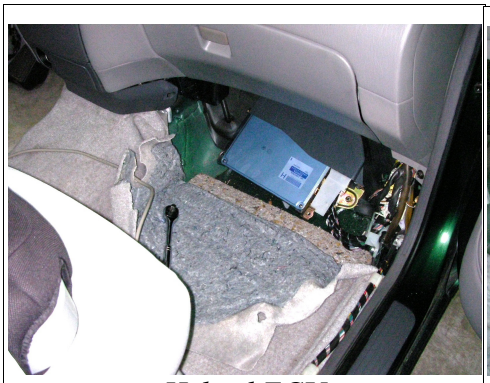
Connecting to Hybrid ECU

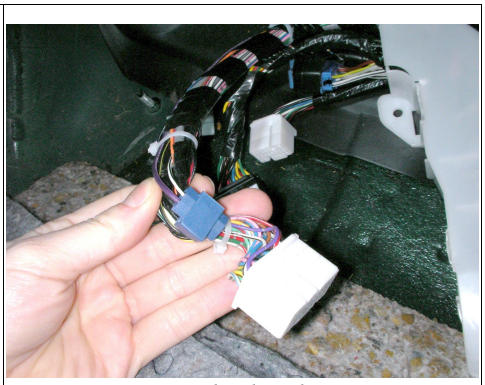
Wire Splice

After installing the panel you will find 3 wires coming from the panel switch board. They will need to be spliced into the wires coming out of the Hybrid ECU (computer) 3 wire splices are included with the kit for this purpose. You will need to find the ECU under the carpet on the front-passenger-side floorboard. Then remove the metal plate covering the HV ECU.



Hybrid ECU

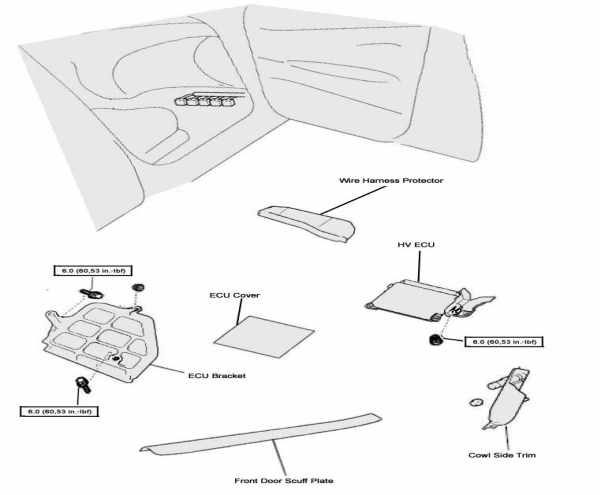
Hybrid ECU Unbolted



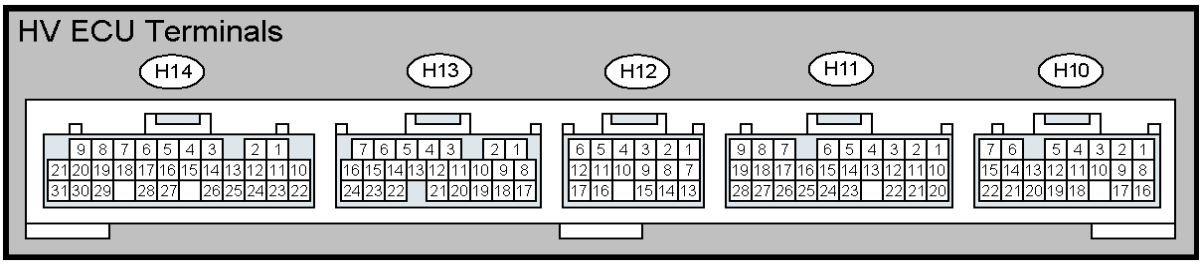
Finished Splice

Use the diagram below to help you find the correct wire. The diagram shows the numbered connectors as they would appear by looking at the ECU itself, not by looking at the ends of the cables (they would appear backwards) The connections are as follows:

- **Green** (ignition ready) - Connect this wire to H12-2 (grey wire) on the Prius ECU.
- **Brown** (ground) - Connect this wire to H14-31 (White or Black wire) on the Prius ECU.
- **White** (EV Mode) - The white wire is not used on the 2000-2003 Model Prius.

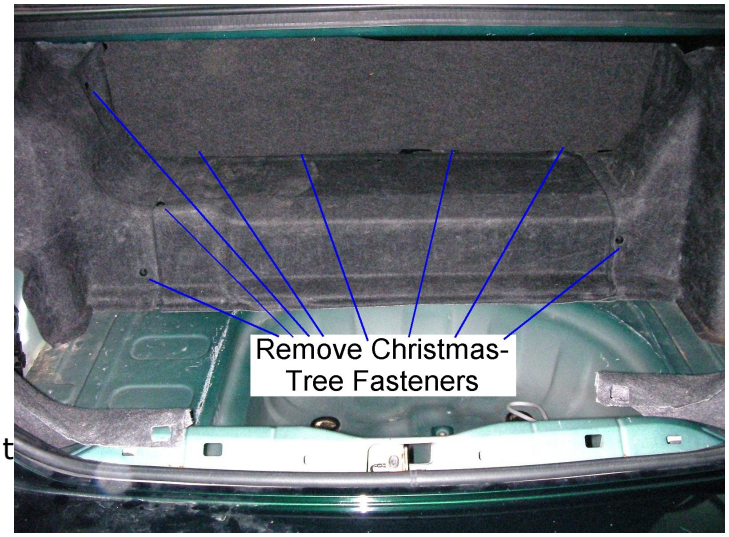


After Splicing the cable, route it up behind the dash, using zip-ties where possible to fasten the new cable to existing wire-harnesses. Avoid any area with sharp edges or objects that move, as over time they could damage the wire and cause a short. Eventually, this cable will meet up with the back of your panel-switch and connect to it via the 3 spade-connectors.



Connecting to High Voltage Lines

The first thing you'll need to do is remove the service plug. This is an important safety step that must be followed, otherwise you could end up killing yourself. To access it, you'll need to remove the carpet covering of the stock hybrid battery located in the trunk. There are little "christmas tree fasteners" which are made of plastic and simply have to be pulled or pryed out. The center 4 shown in the image on the right are actually located behind the seat and you will not be able to access them until the seat is removed, however, you can go ahead and lift the carpet up enough to pull the service plug out.

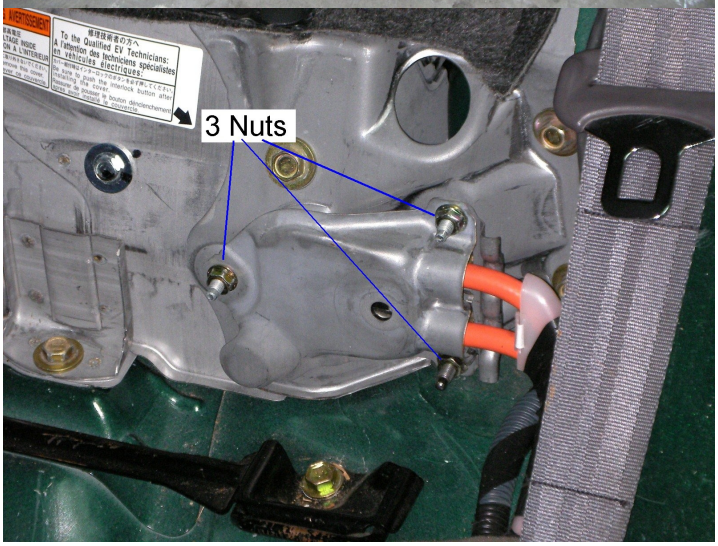


The service plug is an orange handle that folds down, and pulls out. (see picture to right)

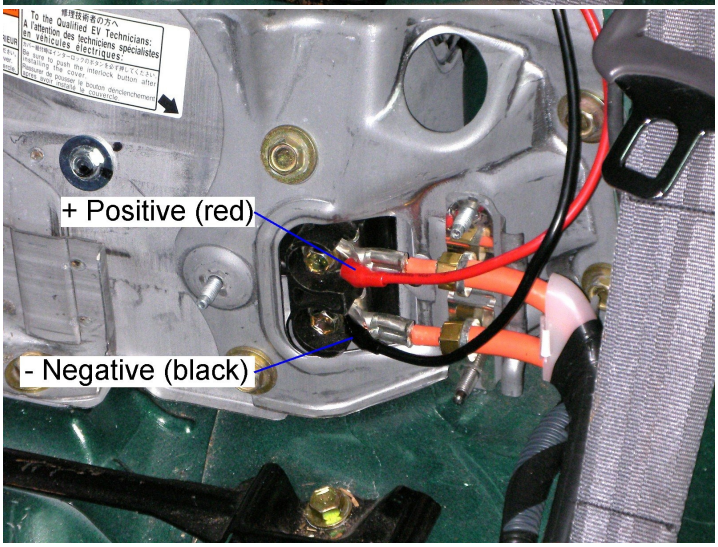
Then you can begin to remove the back seats. First, start by forcefully pulling up on the bottom part of the rear seats. There are two snaps that hold the rear seat down, and that is all. The best place to pull up is near where your feet would be if you were sitting in the back seat. Once your remove the bottom part, you will expose 3 bolts which are holding down the back part of the rear seat. (see picture to right)

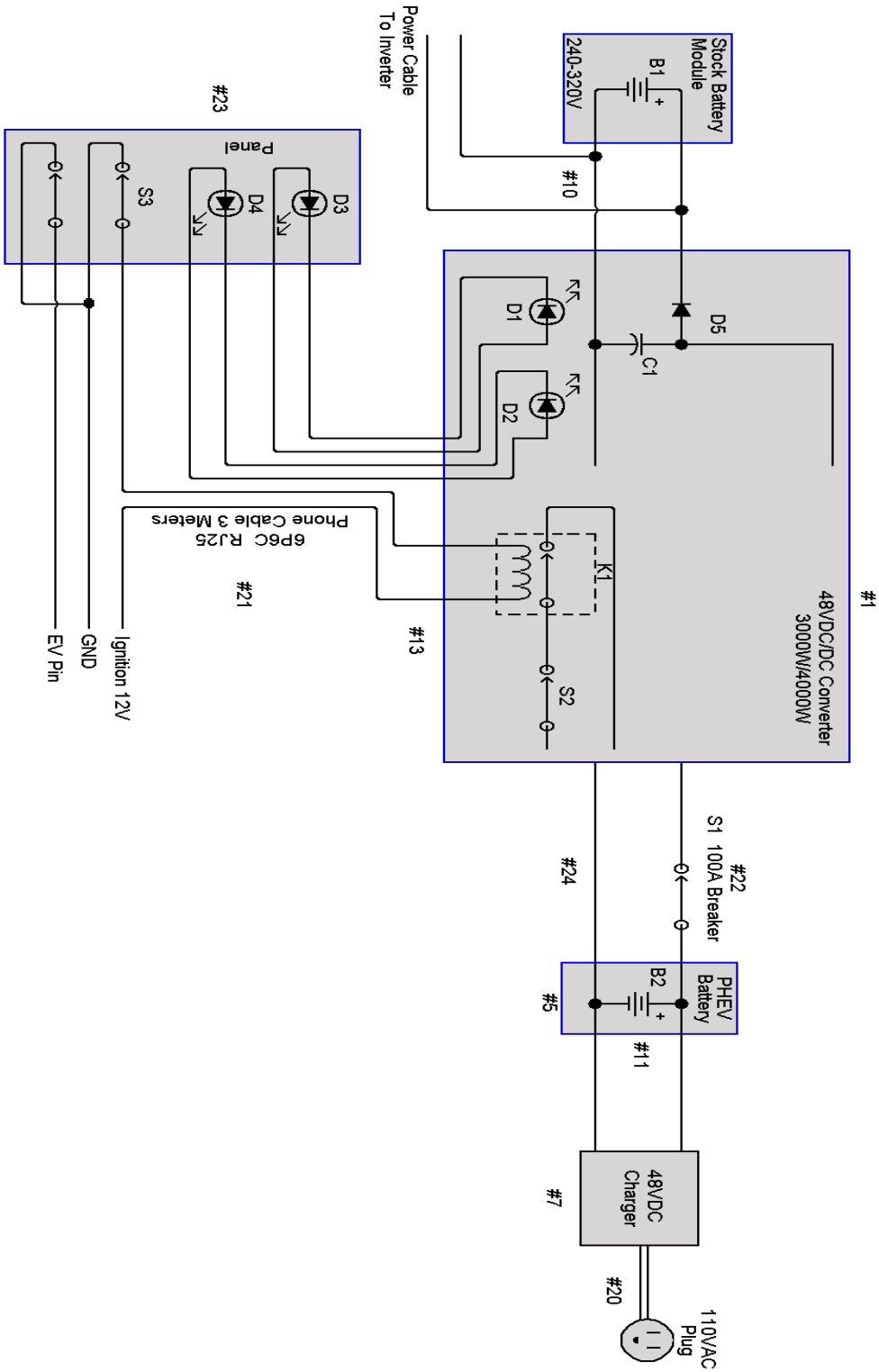
The upper-back part of the seat is held in place by 3 hooks. The trick to removing it is to get the seat-belts out of the way, and forcefully lift the seat up until you feel the hooks disengage.

Once the rear seats are off, you will be able to see where the HV cables connect to the HV battery pack. There are 3 nuts to remove the safety cover. DO NOT REMOVE THIS COVER UNLESS YOU HAVE PULLED THE SERVICE PLUG!



You may now proceed to piggyback the HV wires from the enginer kit. Be sure to pay attention to the polarity, following the picture to the right. When re-installing the safety plate, if it appears to put a lot of pressure on the newly installed wires, then you may use some small washers to space the plate out a little further.




Power Cable
To Inverter
Stock Battery
Module
240-320V
B1
#10
#23
Panel
D3
D4
S3
D1
D2
D5
C1
48VDC/DC Converter
3000W/4000W
#1
6P6C RJ25
Phone Cable 3 Meters
#21
#13
K1
S2
EV Pin
GND
Ignition 12V
#24
S1 100A Breaker
#22
PHEV
Battery
B2
#5
#11
48VDC
Charger
#7
#20
110VAC
Plug

Daily Operation

Keep in mind that the 2000-2003 Toyota Prius does not have a manual EV (Electric Vehicle) mode. However, the vehicle can and does use EV mode when conditions are right for it. In order for EV mode to work, the following conditions must be met:

- I.C.E. (Internal Combustion Engine) must be warmed up to operating temperature.
- A/C must be off, or at least not needed at the time.
- Must not be accelerating hard.
- Battery must not be discharged.

In order to maximize the effectiveness of the PHEV kit, try using these techniques.

- Use the I.C.E. to accelerate to your desired speed, then let off of the accelerator pedal for a moment and slowly re-engage. This is known as "pulse-and-glide" and with practice, you can often convince the vehicle to enter EV mode. Works best on flat-ground or down-hill slopes, but can sometimes work on up-hill grades if not too steep.
- Keep the A/C turned off if at all possible. Use the outside air ventilation or crack the windows for cooling.
- Accelerate and brake as gently as possible, not only does this use less power but gentle braking will maximize regenerative braking.
- Turn the kit off a mile or two before you begin a long descent. The purpose is to allow the stock hybrid battery to drain a little bit, that way you'll have room in the battery for regenerative braking down that long descent.
- Try to stay within 55 to 60 mph on the highway, faster speeds cause more wind-resistance and decrease fuel economy.
- Make sure your tires are properly inflated. Low tires hurts fuel economy.
- Check your brakes and alignment. These can also adversely affect fuel economy.

Engine Warmup – Be aware that the first few minutes of driving, especially during winter, the I.C.E. will be cold. The Prius engine computer is designed to dump as much fuel as necessary into the I.C.E. To warm it up as quickly as possible. This is done both for emissions and fuel-economy reasons. The PHEV kit will not show much improvement in fuel economy during the first few minutes of driving.

LEDs – The switch panel on your dash has two indicator LEDs. The green indicates the kit is turned on. The red indicates a problem, most likely that your batteries are low.

Troubleshooting

If your PHEV kit doesn't seem to be working, here are some things to check:

- Is the main breaker turned on?
- With the PHEV kit off, measure the voltage on the PHEV battery pack. With the car running, turn the PHEV kit on and watch the voltage, it should drop.
- With the PHEV kit off, measure the voltage of the stock hybrid battery. This can be checked on the red and black cables that go from the converter to the hybrid battery. With the car running, turn the PHEV kit on and watch the voltage, it should rise. (Warning – Wear insulating gloves and all other precautions when measuring voltage on stock hybrid pack.)
- If the green LED never lights up when the switch is on, test the wires going to the hybrid ECU. With a volt-meter you should be able to see a 12V power source on the ECU-Ready, combined with the ground wire. It is possible your splice isn't conducting.